CLINICAL STUDY

COMPARISON OF DIFFERENT TECHNIQUES AND GRAFT MATERIALS IN THE ENDOSCOPIC EAR SURGERY

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SUMMARY

Objectives: It was aimed to compare the different graft materials and surgical techniques in transcanal endoscopic tympanoplasty.

Material and Methods: In this retrospective study, 103 patients (mean age of 37.16±13.14 years) were enrolled. Patients were divided into groups according to the graft materials (cartilage or perichondrium) and the surgical techniques (underlay or over-underlay). Anatomical and audiological outcomes were compared.

Results: There was no statistically difference in the surgical techniques. The graft was intact in 58 (90.6%) patients in the underlay group, in 31 (79.5%) patients in the over-underlay group. There was no statistically significant difference between the cartilage (92.2%) and the perichondrium (80.8%) groups ($p>0.05$). The pre-operative and post-operative air-bone gap values were statistically significantly different in all patients and each perichondrium, cartilage, underlay, over-underlay group ($p<0.05$). ABG values in all frequencies and in 1000 Hz the cartilage group was statically significantly different from the perichondrium group ($p<0.05$). There were significant differences in the cartilage, perichondrium, and underlay groups in 4000 Hz. But there was no statistical difference in the over-underlay group at 4000 Hz.

Conclusions and Significance: After learning curve, transcanal endoscopic tympanoplasties can be performed successfully with different graft materials and different surgical techniques.

Keywords: Endoscopic tympanoplasty, cartilage, perichondrium, underlay, over-underlay

ENDOSKOPİK TİMPANOPLASTİDE UYGULANAN FARKLI CERRAHİ TEKNİKLERİN VE GREFT MATERYALLERİNİN KARŞILAŞTIRILMASI

ÖZET

Amaç: Bu çalışmada, endoskopik timpanoplasti uygulanan hastalarda kullanılan farklı greft materyallerinin ve farklı greftleme tekniklerinin karşılaştırılması amaçlanmıştır.

Gereç ve Yöntemler: Çalışmamızda endoskopik timpanoplasti operasyonu geçiren toplam 103 hasta (ort.yaş 37.16±13.14) retrospektif olarak incelendi. Hastalar operasyon sırasında kullanılan greft materyallerine göre (kartilaj veya perikondrium) ve greftleme sırasında kullanılan cerrahi tekniklere göre (underlay veya over-underlay) gruplara ayrıldı. Gruplar arası greft tutma başarısı ve odyolojik sonuçlar karşılaştırıldı.

Bulgular: Tüm hastalarda greft tutma başarısı %86,4 (89/103) olarak bulundu. Greft tutma başarısı açısından uygulanan cerrahi teknikler ve kullanılan greft materyalleri arasında istatistiksel olarak anlamlı fark saptanmadı. Underlay teknik kullanılmış grupta 58 hastada (%90), over-underlay teknik kullanılan grupta 31 (%79,5) hastada greft intakt bulundu. Kartilaj kullanılan grupta %92.2, perikondrium kullanılan grupta %80.8 oranında greft intakttı($p>0.05$). Tüm gruplarda preoperatif ve postoperatif hava kemik yolu (HKY) değerleri istatistiksel olarak anlamlı değişiklik gösterdi ($p<0.05$). Her frekans için preoperatif ve postoperatif HKY ayrı ayrı değerlendirildiğinde 1000 Hz de kartilaj greft kullanılan grup, perikondrium kullanılan gruptan istatistiksel olarak anlamlıydı ($p<0.05$). 4000 Hz de kartilaj, perikondrium ve underlay teknik uygulanan gruplarda anlamlı fark varken, over-underlay teknik uygulanan grupta anlamlı fark saptanmadı.

Sonuç: Belirli öğrenme süreci sonrasında, endoskopik timpanoplastiler farklı greft materyalleri ve farklı greftleme teknikleri kullanılarak başarıyla uygulanabilir.

Anahtar Sözcükler: Endoskopik timpanoplasti, kartilaj, perikondrium, underlay, over-underlay

INTRODUCTION

Tympanic membrane perforation usually occurs in chronic otitis media and can be managed by tympanoplasty operations. In these surgeries, the primary purpose is to eradicate the infection, ensure a clean and dry middle ear cavity by restorating the perforated tympanic membrane and the second aim is to improve the hearing loss if possible. Varied surgical techniques and different graft materials have been used to reconstruct the tympanic membrane. Graft materials can be changed according to the patient, status of the disease, anatomic variations, size or localization of the perforation, being the primary or revision surgery, and the choice or experience of the surgeon. Overlay, underlay and over-underlay surgical techniques can also change according to

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these criteria. Temporalis fascia is the most preferred graft material[1]. At the end of the 1990s endoscopes became popular in otology and audiologists have been performing tympanoplasty with endoscopes via transcanal approach, so recently perichondrium and cartilage began to be preferred more than before. Previously the cartilage graft was used in tympanoplasty in advanced cases such as eustachian tube dysfunction, retraction pockets, revision, or total/subtotal perforated eardrums only[2]. The advantages of the endoscopic ear surgery are wider and more detailed visualization, not affected by external auditory canal folds, needing no extra incision or canaloplasty, the possibility of visualization of hidden recesses in the middle ear especially with the angled lenses, postoperative less pain or cosmetic deformities, shorter hospitalization. Needing a learning curve, using one hand in the surgery, absence of depth perception, and especially thermal injury risk are the disadvantages of endoscopic ear surgery[3].

In this study, it was aimed to investigate comparing different graft materials and different surgical techniques in endoscopic tympanoplasty.

MATERIAL and METHODS

In this retrospective study patients who underwent endoscopic tympanoplasty were reviewed between June 2016 - April 2020 in Izmir Bozyaka Training and Research Hospital. Patients who underwent mastoidectomy were affected by cholesteatoma, younger than 18 years old, or used microscope with endoscope and myringoplasties were excluded from the study. 128 patients' data were reached and all patients were reexamined. 25 patients that can't be reached nor attend follow-up examinations were excluded. A total of 103 patients (103 ears) who had tympanic membrane perforation with non-complicated or not affected by cholesteatoma included our study. Their complaints were evaluated, otoscopic and audiological examination was reported in the postoperative period. The study was approved by the Ethics Committee of our hospital and adhered to the principles outlined in the Declaration of Helsinki (2020/06).

All operations were performed by using a rigid endoscope (3 mm, 0º, 15-cm lens) under general anesthesia. Age, gender, operation date, side, performing ossiculoplasty or not, which graft material and surgical technique were preferred, being primer or revision surgery; status of middle ear mucosa and ossicular chain; the presence of tympanosclerosis, ossicular chain movement, materials used for hearing reconstruction, preoperative audiogram findings were recorded from patients" datas. Then all patients called for examination and asked for their complaints, otoscopic and audiological examinations were reported.

103 patients were divided into two groups according to the kind of graft materials used (cartilage or perichondrium). In cartilage tympanoplasties, we performed cartilage block with perichondrium or supported perichondrium with pieces of cartilage. We compared the anatomical and audiological differences between groups. Also, patients were compared with the surgical technique (underlay or over-underlay). We evaluated the outcomes as anatomical and audiological results. Tympanic membrane status (perforated/intact) was noted as the anatomical success. Average of bone and air-conduction frequencies 500-1000-2000-4000 Hz calculated. Air-bone gap (ABG) closure and recovery levels based on each frequency (500, 1000, 2000, 4000, 8000) were evaluated in the audiological results.

1. Surgical technique

All operations were performed by using a rigid endoscope (3 mm, 0º, 15-cm lens) under general anesthesia. After the injection of local anesthetic agents, the edges of the perforation were freshened with a pick. 6-12 radial incisions were combined with the lateral circumferential incision in the posterior wall. The tympanomeatal flap and the annulus were elevated. Middle ear cavity, ossicular chain mobility and stability were assessed. Reconstruction was performed in patients with ossicular chains disconnected. Tragal cartilage with its perichondrium was harvested via a 2 mm from the margin of the tragus scin. According to the size, status, or localization of the perforation, cartilage or perichondrium graft was preferred, and underlay or over-underlay techniques were performed. In the over-underlay technique, manubrium mallei desepitelised. Perichondrium graft was used in some patients. And in the other patients first, perichondrium was used then a

block cartilage piece (size was changed according to the size of perforation) was placed between the eardrum and perichondrium. Cartilage/perichondrium island graft was performed to the total or subtotal perforations. Full-thickness cartilage was used in cartilage graft group. The tympanomeatal flap was reposed and the external auditory canal was packed with gel foams.

2. Statistical analysis

The statistical analysis was performed by using the SPSS version 22. In the study, the descriptive data were presented in the median, the smallest, the largest value for numerical variables, and the percentage for categorical variables. The concordance of the normal distribution of the data in the groups was tested with Kolmogorov Smirnov. Comparisons between the groups were made by Mann-Withney U test for the numerical variables, by Chi-square or Fisher tests for the categorical variables. P values of <0.05 were considered statistically significant.

RESULTS

Between June 2016 and April 2020, 155 patients underwent endoscopic tympanoplasty in Otolaryngology-Head and Neck Surgery Department Izmir Bozyaka Training and Research Hospital. In total 103 patients were included in the study. The mean age of all patients was 37.16 ± 13.14 (range 18 to 65 years). 59 (57.3%) of the patients were female, 44 (42.7%) were male; 58 (56.3%) of them were right ear, 45 (43.7) of them were left side. The mean follow-up period was 30,36±12,6 (9-60) months. Type-1 tympanoplasty was performed in 98 patients, the ossicular chain was reconstructed in 5 patients. The ossicular chain was reconstructed with bone cement, titanium PORP, autograft incus. Of all 103 patients, 94 of them were the primary surgery and 9 were revision. The success rate of the tympanic membrane closure of all patients was 86,4% (89/103 ears) in all patients. The median air-bone gaps preoperatively and postoperatively in all patients were 21.25 dB and 12.5 dB respectively.

We classified our patients according to the surgical technique applied (underlay group / over-underlay group) and the graft materials (perichondrium group and cartilage group) used. The pre-operative and post-operative air-bone gap values were statistically significantly different in all patients and each perichondrium, cartilage, underlay, over-underlay group (Table-1 and Table-2).

Preoperative and postoperative air-bone gaps for each frequency (500, 1000, 2000, 4000) were evaluated. In 500, 1000, and 2000 frequencies there were statistically significant differences in all groups.There were significant differences in the cartilage, perichondrium, and underlay groups in 4000 Hz. But there was no statistical difference in the over-underlay group at 4000 Hz. (Table-3 and Table-4).

The patients were classified according to the graft materials used as the cartilage group and perichondrium group. Cartilage was used in 51 patients, perichondrium was used in 52 patients. There was no statistically significant difference in the distribution of the age, gender, side of the ear, status of the middle ear (presence of tympanosclerosis, ossicular chain mobility), pre-operative air-bone gap, bone-conduction threshold values, and the follow-up period in two groups (Table-5). The preoperative median air thresholds were better in the cartilage group according to the perichondrium group, this was statistically significant ($p<0.05$). Comparing the two groups regarding the median postoperative ABG, there was a statically significant difference in the cartilage group ($p<0.05$). We compared ABG values in all frequencies and in 1000 Hz the cartilage group was statically significantly different from the perichondrium group ($p<0.05$). We also reported the postoperative air thresholds at 8000 Hz, there was no statistically significant difference between the groups (Table-6). In the postoperative period, the graft was intact in 47 (92.2%) patients in the cartilage group, in 42 (80.8%) patients in the perichondrium group (Table-5). There was no statistically significant difference between the two groups for the graft success rate ($p>0.05$).

We classified the patients according to the surgical technique applied as the underlay group and the over-underlay group. The underlay technique was performed in 64 (43 female, 21 male) patients and over-underlay technique was performed in 39 (28 female, 24 male) patients. There was a statistically significant gender difference between the two groups. There were no statistically significant differences in the

distribution of the age, side of the ear, status of the middle ear (presence of tympanosclerosis, ossicular chain mobility), preoperative air-bone gap, bone or air-conduction threshold values, being primer or revision surgery, and the follow-up period in two groups. Comparing the two groups regarding the median postoperative air threshold values was a statically significant difference in the underlay group. The graft was intact in 58 (90.6%) patients in the underlay group, in 31 (79.5%) patients in the over-underlay group. Postoperative tympanic membrane closure, median postoperative ABG, postoperative ABG values in all frequencies (500, 1000, 2000, 4000), postoperative air thresholds at 8000 Hz were no statistically significant differences between the groups (Table-4).

Table-1: Preoperative and postoperative median air-bone gaps findings in all patients, the cartilage and the perichondrium groups. (ABG: Air-bone gap).

	Preop, ABG	**Postop, ABG**	***p values**
	median(min-max)	median(min-max)	
Total (n=103)	21.25(6.25-52.5)	12.5(0-62.5)	**<0,001**
Cartilage (n=51)	21.25(6.25-46.25)	11.25(0-58.75)	**<0,001**
Perichondrium (n=52)	21.88(7.5-52.5)	15(2.5-62.5)	**<0,001**

Table-2: Preoperative and postoperative median air-bone gaps findings in all patients, underlay and over-underlay groups. (ABG: Air-bone gap).

	Preop, ABG	**Postop, ABG**	***p values**
	median(min-max)	median(min-max)	
Total (n=103)	21.25(6.25-52.5)	12.5(0-62.5)	**<0,001**
Underlay (n=64)	21.25(6.25-52.5)	11.25(0-58.75)	**<0,001**
Over-underlay (n=39)	21.25(7.5-48.75)	16.25(0-62.5)	**<0,001**

Table-3: Preoperative and postoperative air-bone gaps at 500, 1000, 2000, 4000 Hz in all patients, the cartilage and the perichondrium groups (ABG: Air-bone gap).

	Preop 500 ABG	***Postop 500 ABG***	**P**	***Preop 1000 ABG***	***Postop 1000 ABG***	**P**	***Preop 2000 ABG***	***Postop 2000 ABG***	**p**	***Preop 4000 ABG***	***Postop 4000 ABG***	**P**
	Median (min-max)	Median (min-max)		Median (min-max)	Median (min-max)		Median (min-max)	Median (min-max)		Median (min-max)	Median(min-max)	
Total	25(5-70)	15(-10-70)	<0,001	20(5-55)	15(-10-70)	<0,001	15(0-45)	10(-15-60)	<0,001	20(0-55)	15(-20-75)	0,001
Cartilage	20(5-50)	10(-10-70)	<0,001	20(5-55)	10(-10-70)	<0,001	15(0-40)	10(-10-60)	<0,001	20(0-45)	10(-20-50)	0,008
Perichondrium	30(10-70)	15(0-55)	<0,001	20(5-55)	10(0-60)	<0,001	10(5-45)	5(-15-60)	0,001	15(5-55)	10(-20-75)	0,025

Table-4: Preoperative and postoperative air-bone gaps at 500, 1000, 2000, 4000 Hz in all patients, underlay and over-underlay groups (ABG: Air-bone gap).

	Preop 500 ABG	***Postop 500 ABG***	**P**	***Preop 1000 ABG***	***Postop 1000 ABG***	**P**	***Preop 2000 ABG***	***Postop 2000 ABG***	**p**	***Preop 4000 ABG***	***Postop 4000 ABG***	**P**
	Median (min-max)	Median (min-max)		Median (min-max)	Median (min-max)		Median (min-max)	Median (min-max)		Median (min-max)	Median(min-max)	
Total	25(5-70)	15(-10-70)	<0,001	20(5-55)	15(-10-70)	<0,001	15(0-45)	10(-15-60)	<0,001	20(0-55)	15(-20-75)	0,001
Underlay	20(5-70)	10(-10-70)	<0,001	20(5-55)	15(-10-70)	<0,001	15(0-40)	10(-10-70)	<0,001	20(0-55)	15(-20-50)	0,003
Over-underlay	30(10-55)	15(0-55)	<0,001	20(5-50)	15(0-60)	0,003	15(0-45)	10(-15-60)	0,016	20(5-55)	20(-20-75)	**0,076**

Table-5: Comparison of the subject data and examination findings in both groups (cartilage and perichondrium groups, underlay and over-underlay groups).

	Cartilage (n=51)	**Perichondrium (n=52)**	***p values (between cartilage-perichondrium)**	**Underlay (n=64)**	**Over-underlay (n=39)**	***p values (between underlay-over-underlay)**
Age (median(min-max))	34(18-61)	40(19-65)	0,187	34(18-65)	36(18-65)	0,965
Gender						
Female (n, %)	31(60,8)	28(53.8)	0,477	43(67.2)	28(53.8)	**0,009***
Male (n, %)	20(39,2)	24(46.2)		21(32.8)	24(46.2)	
Ear						
Right (n, %)	25(49)	33(63.5)	0,140	32(50)	26(66.7)	0,098
Left (n, %)	26(51)	19(36.5)		32(50)	13(33.3)	
Middle ear mucosa			0,617			1.000
Normal (n, %)	46(90.2)	47(90.4)		58(90.6)	35(89.7)	
Tympanosclerosis (n, %)	5(9.8)	5(9.6)		6(9.4)	5(10.3)	
Primer / Revision			**0,003***			1.000
Primer (n, %)	51(100)	43(82.7)		58(90.6)	36(92.3)	
Revision (n, %)	0(0)	9(17.3)		6(9.4)	3(7.7)	
Ossicular chain						
Intact (n, %)	48(94.1)	50(96.2)	0,678	60(93.8)	38(97.4)	0.647
Disconnecte	3(5.9)	2(3.8)		4(6.3)	1(2.6)	

d (n, %)						
Ossicular chain mobility			0,633			0,333
Immobil (n, %)	2(3.9)	3(5.8)		3(4.7)	2(5.1)	
Restricted (n, %)	2(3.9)	4(7.7)		2(3.1)	4(10.3)	
Mobil (n, %)	47(92.2)	45(86.5)		59(92.2)	33(84.6)	
Postoperative otoscopy	47(92.2)	42(80.8)	0,092	58(90.6)	31(79.5)	0,110
Normal (n, %)						
Perforated (n, %)	4(7.8)	10(19.2)		6(9.4)	8(20.5)	

Table-6: Comparison of the audiological findings in cartilage/perichondrium and underlay/over-underlay groups.

	Cartilage (n=51)	**Perichondrium (n=52)**	***p values**	**Underlay (n=64)**	**Over-underlay (n=39)**	***p values**
Preop.ABG (median(min-max))	21.25 (6.25-46.25)	21.875 (7.5-52.5)	0,090	21.25 (6.25-52.5)	21.25(7.5-48.75)	0,188
Postop.ABG (median(min-max))	11.25 (0-58.75)	15(2.5-62.5)	**0,020***	11.25 (0-58.75)	16.25(0-62.5)	0,103
Preop 500 ABG	20(5-50)	30(10-70)	0,015	20(5-70)	30(10-55)	0,030
Postop 500 ABG	10(-10-70)	15(0-55)	0,106	15(0-55)	15(0-55)	0,213
Preop 1000 ABG	20(5-55)	20(5-55)	0,174	20(5-55)	20(5-50)	0,414
Postop 1000 ABG	10(-10-70)	15(0-60)	**0,020**	15(-10-70)	15(0-60)	0,095
Preop 2000 ABG	15(0-40)	17,5(0-45)	0,474	15(0-40)	15(0-45)	0,629
Postop 2000 ABG	10(-10-60)	10(-15-60)	0,200	10(-10-60)	10(-15-60)	0,548
Preop 4000 ABG	20(0-40)	20(5-55)	0,477	20(0-55)	20(5-55)	0,161
Postop 4000 ABG	10(-20-50)	15(-20-75)	0,083	15(-20-50)	10(-20-75)	0,165
Preop,8000h *(median(min-max))*	40(10-100)	50(10-110)	0,079	45(10-110)	45(10-110)	0,720
Postop,8000h *(median(min-max))*	45(10-80)	45(5-110)	0,142	45(10-100)	45(5-110)	0,548

DISCUSSION

Different graft materials have been used in tympanoplasty operations. Temporalis muscle fascia is the most preferred graft material. The fascia graft is useful, thin and adaptable[1]. In course of time, due to the reperforations, different and stronger materials were started to search. In particular, perichondrium and cartilage have begun to be used more than before, especially with the frequent use of endoscopes in otological surgeries. In this study, perichondrium and cartilage grafts were compared with each other for anatomic and functional results in the patients that underwent endoscopic tympanoplasty.

Recently many otologic surgeries like myringoplasty, stapedectomies, tympanoplasties, cholesteatoma surgeries can be performed by endoscopes alone[4]. No extra canaloplasty or incision, more visualization, or not affected from external ear canal are the advantages of endoscopes. But learning curve, one-handed surgery, absence of deep perception are the disadvantages. Also, thermal injury is one of the concerning points for many otologists because of the possibility of being harmful to middle or inner ear structures[5]. It has been demonstrated that endoscope usage in the middle ear caused temperature rises at the round window in the experimental and cadaveric studies[6,7]. To avoid thermal damage it is recommended not to hold the endoscope in the same place throughout the surgery, periodically washing the middle ear cavity and endoscope tip, using a light-emitting diode (LED) light source with small diameter endoscopes. Otherwise, Khan et al. used an endoscope holder in 179 tympanoplasties, Kaya et al. studied with xenon light source and no complications due to the thermal injury encountered in their studies[8,9]. In this study, a xenon light source and 3 mm diameter, 15 cm rigid, 0º endoscope were used. No complications related to thermal damage were observed in any patient.

In endoscopic tympanoplasties, fascia, perichondrium and cartilage are the most preferred used grafting materials. There are numerous studies in the literature that include the success rates or comparison of these graft materials. In our study, we aimed to investigate the perforation closure and audiological success rate of endoscopic tympanoplasties comparing tragal cartilage and its perichondrium. Ozdemir et al. compared the anatomical and functional outcomes of grafting with the temporalis muscle fascia with the tragal cartilage perichondrium in 151 patients that underwent endoscopic tympanoplasty. They didn't find any statistical difference between the two groups in terms of the graft retention success rate and postoperative air-bone GAP closure[10]. Hsieh et al. used tragal perichondrial graft, Ozgur et al. used chondroperichondrial composite graft in endoscopic tympanoplasty, they reported a high success rate of perforation closure and significant improvements of air-bone gaps[11]. 51 cartilage grafts compared with 52 perichondrium grafts. There was a statically significant difference in the cartilage group ($p<0.05$), in the postoperative ABG (21.25 dB preoperative, 11.25 dB postoperative in the cartilage group; 21.88 dB preoperative, 15 dB postoperative in the perichondrium group). The graft success rate was 92.2% (47 patients) in the cartilage group and 80.8% (42 patients) in the perichondrium group. There was no statistically significant difference between the two groups for the graft success rate ($p>0.05$). The success rate of the tympanic membrane closure of all patients was 86,4% (89/103 ears).

Although cartilage is mostly preferred in revision surgeries, attic retractions, and patients with eustachian tube dysfunction, it is also frequently used in primary surgeries with or without perichondrium. Various designs of composite cartilage-perichondrial graft used for tympanic membrane reconstruction are described[12]. Tragal cartilage and its perichondrium can be obtained easily and can be placed more easily than other graft materials in the perforated area due to its rigidity in endoscopic surgeries. But in the postoperative period, it can hide middle ear pathologies like cholesteatoma and effusion. In the suspicion of middle ear pathologies, imaging techniques can be used.

There have been many varieties on the size, thickness and shape of the cartilage grafts used in tympanoplasty. The cartilage can be used full-thickness, partial thickness, pieces or whole while restoring the eardrum[12]. Cartilage is a strong graft material, provides mechanical stability for the tympanic membrane and is successful at the closure of the perforated eardrums[13] but concerns are about the effect on hearing because of its thickness. It is thicker than other graft materials. Many studies are comparing the cartilage and most preferred graft material temporalis muscle fascia[14,15]. Most of them reported no statistically significant difference in hearing[14]. Postoperative hearing results were better in cartilage tympanoplasty compared to the fascia in some studies[16]. In this study, postoperative hearing results in the cartilage graft group were significantly better than the perichondrium graft group.

The cartilage thickness that has to be used is also a matter of debate. Some otologists emphasized that successful audiological results can be obtained with a 0.5 mm thick cartilage[17]. Conversely, Dornhoffer emphasized that full-thickness cartilage graft should be preferred while restoring the tympanic membrane, because of the presence of perichondrium the graft can be curled if it is thinned in his 1000-case study. He also acquired good audiological results with full-thickness cartilage[18]. In another study, comparing the thickness of the cartilages, there were no differences in postoperative hearing results, between the full-thickness and half-thickness[19]. In our study, both the tragal perichondrium and cartilage graft were successful in restoring the tympanic membrane. There were some differences in audiological outcomes. Comparing the graft materials in each group preoperative and postoperative median ABG was statistically significantly different but comparing the two groups postoperative median ABG was significantly different in the cartilage group. And postoperative 1000 Hz ABG was better in the cartilage group. Full-thickness cartilage was performed in the cartilage group. Despite the thought that hearing outcomes could be worse due to the thickness of the cartilage, the audiological results were better in the cartilage group. Parelkar et al. investigated the thickness of the cartilage in endoscopic cartilage tympanoplasty. They compared the full thickness and partial thickness of tragal cartilage. They reported that the graft take-up rate full-thickness cartilage was significantly better and hearing improvement was very similar in both two groups[2].

Onlay, underlay and over-underlay techniques can be performed in the tympanoplasties. These techniques are changed from various factors like perforation localization, manubrium position, surgeon's experience, etc. In our study, we compared underlay and over-underlay techniques. To our knowledge, this is the first study comparing the underlay and over-underlay grafting techniques in the endoscopic tympanoplasty. Both of the surgical techniques, underlay and over-underlay were successful too, in the restoration of the eardrum. The graft success rate was 90.6% (58 patients) in the underlay group and 79.5% (31 patients) in the over-underlay group. There was no statistically significant difference between the two groups in the success rate of the closure of the tympanic membrane. Both underlay and over-underlay groups were successful in postoperative audiological outcomes. Postoperative air-conduction thresholds were statistically significantly different in the underlay group. Evaluated preoperative and postoperative air-bone gaps for each frequency (500, 1000, 2000, 4000) were statistically significantly different in each perichondrium, cartilage, underlay and over-underlay group ($p<0.05$). Only in the over-underlay group at the 4000 Hz values were not statistically significantly different (preoperative 20 dB, postoperative 20 dB; $p>0.05$). As it is known that minimal damage to the ossicular chain with drill or manipulation, firstly high frequency damage starts. In over-underlay technique manubrium mallei are skeletonized by microsurgical tools. In the underlay technique, this manipulation isn't applied. Depending on the one-hand surgery in the endoscopic tympanoplasties, the trauma to the manubrium may damage the ossicular chain when this manipulation was performed. Because of this reason, preoperative and postoperative ABG in 4000 Hz may not have shown a statistically significant difference. However, in ossicular

chain damage, we expect all frequencies to be affected, not just 4000 Hz.

Tympanoplasty success rates vary depending on various factors. Middle ear status, size or localization of the perforation, experience of the surgeon, patient-dependent factors, comorbidities, postoperative period, etc. affect the success rates. Different graft materials and different surgical techniques can be performed. Graft materials or different surgical techniques should be selected according to the patients and disease status.

A limitation of this study is that the relationship between perforation size and location and graft success was not evaluated, as some patients were not specified in the examination data. Perforation size and localization may affect the results in the choice of graft material and technique.

After the learning curve, transcanal endoscopic tympanoplasties can be performed easily. The operation times will be shorter according to the postauricular or endaural incisions because of the no need for extra incisions or canaloplasty. No need for a haircut or giving head position, being less invasive, shorter hospitalization times, better cosmetic results are the other advantages of the endoscopic tympanoplasties[20].

Conflict and Interest:

There is no conflict and interest.

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